Junior doctors' knowledge and perceptions of antibiotic resistance and prescribing: a survey in France and Scotland

C. Pulcini[1,2], F. Williams[3], N. Molinari[4], P. Davey[3,5] and D. Nathwani[5]

1) *Centre Hospitalier Universitaire de Nice, Service d'Infectiologie, Hôpital l'Archet 1, Nice, France,* 2) *Université de Nice Sophia-Antipolis, Faculté de Médecine de Nice, Nice, France,* 3) *Division of Community and Population Sciences and Education, University of Dundee, Dundee, UK,* 4) *Service Biostatistique, Epidemiologie, Santé Publique et Information Médicale, CHU de Nîmes, Hôpital Carémeau, Nîmes, France and* 5) *Infection Unit, Ninewells Hospital and Medical School, Dundee, UK*

Abstract

Our objective was to assess junior doctors' perceptions of their antibiotic prescribing practice and of bacterial resistance. We surveyed 190 postgraduate doctors still in training at two university teaching hospitals, in Nice (France) and Dundee (Scotland, UK), and 139 of them (73%) responded to the survey. The main results presented in this abstract are combined for Nice and Dundee, because there was no statistical difference for these points between the two hospitals. Antibiotic resistance was perceived as a national problem by 95% of the junior doctors, but only 63% rated the problem as important in their own daily practice. Their perceptions of the causes of antibiotic resistance were sometimes at variance with available medical evidence, with excessive duration of antibiotic treatment and poor hand hygiene practices rarely being perceived as important drivers for resistance. Only 31% and 26% of the doctors knew the correct prevalences of antibiotic misuse and of methicillin-resistant *Staphylococcus aureus* in hospitals, respectively. They preferred educational interventions, such as specific teaching sessions, availability of guidelines or readily accessible advice from an infectious diseases specialist, to improve antibiotic prescribing, rather than restricted prescription of antibiotics. These data provide helpful information for the design of strategies to optimize adherence to good antimicrobial stewardship.

Keywords: Antibiotic prescribing, bacterial resistance, junior doctors, knowledge and attitudes, survey
Original Submission: 1 November 2009; **Revised Submission:** 14 January 2010; **Accepted:** 15 January 2010
Editor: M. Paul
Article published online: 2 February 2010
Clin Microbiol Infect 2011; **17:** 80–87
10.1111/j.1469-0691.2010.03179.x

Corresponding author: C. Pulcini, Centre Hospitalier Universitaire de Nice, Service d'Infectiologie, Hôpital l'Archet 1, Route Saint Antoine de Ginestière, BP 3079, 06202 Nice Cedex 3, France
E-mail: pulcini.c@chu-nice.fr

Introduction

Antibiotic resistance is a growing problem worldwide, with an often negative impact on patient outcomes [1]. Between 20% and 50% of antibiotic use is either unnecessary or inappropriate [2,3], and decreasing it is a necessary first step to curb antibiotic resistance. This knowledge has led to the development of national recommendations to improve antibiotic stewardship in countries such as the USA, France and Scotland [2,4–6]. The evidence suggests that a multifaceted approach is favoured, aimed at improving the organization of the healthcare system and changing physicians' prescribing behaviour [2,7]. Guidelines or similar well-intentioned interventions are often not enough to change behaviour in clinical practice [8]. Few studies on physicians' attitudes towards and knowledge and perceptions of antibiotic resistance and prescribing in the inpatient setting have been published: two in the USA and one in Brazil [9–12]. These results are not necessarily applicable in other settings.

We surveyed junior training-grade doctors from all clinical specialties in two public teaching hospitals (Nice, France, and Dundee, Scotland, UK) to assess their knowledge, attitudes and perceptions concerning antibiotic resistance and prescribing. Our goal was to gain some understanding of this process in two different cultural contexts, so as to enable the design and implementation of more effective antibiotic stewardship interventions in these hospitals.

Participants and Methods

Setting and participants

We conducted a survey of all eligible junior doctors in Dundee, Scotland, UK (November 2007) and Nice, France (January 2008), using a self-administered questionnaire. The term 'junior doctors' referred to doctors after qualification from medical school who were still in their training years. In both countries, doctors were first-year trainees at the same stage in their medical training, after 5 and 6 years of undergraduate training in Dundee and Nice, respectively. Junior doctors were identified in both hospitals using data provided by the University Human Resources Department. Junior doctors eligible for the survey included all juniors prescribing antibiotics in their clinical practice (specialties such as laboratory medicine, radiology, psychiatry and occupational health were excluded) and currently on a clinical rotation (excluding, for example, those on maternity leave or doing research for a degree). In Dundee, only first-year junior doctors (after qualification from medical school and termed foundation doctors) were included, whereas first-year and second-year junior doctors were surveyed in Nice. The level of clinical training and overall competency was deemed equal for both cohorts (in the opinion of C.P. and D.N.). The characteristics of the hospitals in Nice and Dundee are described in Table 1.

Survey instrument

The questionnaire was developed in consultation with a group of experts on questionnaire design and infectious diseases, and after searching the literature for comparable studies [9–11]. The questionnaire was was submitted in a pilot test to ten junior doctors to check comprehension and clarity of the questions. The 56-item self-administered questionnaire collected information on junior doctors' attitudes about antibiotic prescribing, their perception of the importance of the problem of antibiotic resistance, their knowledge of the national prevalence of antibiotic resistance and local prevalence of antibiotic misuse, their beliefs about the causes of antibiotic resistance, and their attitudes about current and potential interventions designed to improve antibiotic stewardship. Data were also collected about their current specialty, the frequency with which they prescribed antibiotics, and past training in antibiotic prescribing. The questionnaire is included in the Supporting Information section (or is available from C.P.), in both English and French (with identical questions).

Most questions about perceptions and attitudes used four-point or five-point Likert-style response options, from very unhelpful/unimportant/unconfident, to very helpful/important/confident. To assess knowledge of the prevalence of antibiotic resistance, junior doctors were asked to estimate the prevalence of resistance in their country for two specific bacterium–antibiotic combinations relevant to clinical practice: *Escherichia coli* resistance to trimethoprim in Scotland

TABLE 1. Nice and Dundee hospitals' characteristics and antibiotic policy

Characteristic	Nice hospital	Dundee hospital
University public teaching hospital	Yes	Yes
Number of beds	1800	900
Prevalence rate of MRSA in 2007	27% (25.8% in France, EARSS data)	34% (34.8% in Scotland, HPS data)
Prevalence of antibiotic misuse in 2005	32–64%	23–30%
Use of antibiotics (DDD)/1000 patient-days) in 2007	376	1250 (possibly overestimated)
Local guidelines	Yes, available on the Internet	Yes, available on the Internet
Antibiotic committee	Yes	Yes
Antimicrobial management team	Yes	Yes
List of broad-spectrum antibiotics requiring approval by ID specialist or microbiologist before prescription	Yes	Yes
Intravenous–oral switch protocol	No	Yes
Availability of ID advice	Face-to-face or by phone, available at all times, on all wards	Mainly through request for clinical consultation, emphasis on internal medicine and general surgery/orthopaedics, but also some advice by phone; only during working hours
Availability of microbiologist advice	By phone during the day	Mainly by phone, but in some areas (e.g. ICU and haematology) clinical consultation is available at all times
Qualification of microbiologists	Medical graduates	Medical graduates
Availability of clinical pharmacists	By phone, available at all times	By phone, available at all times, plus ward rounds during the day
Computer-based prescribing system	No	No
Junior doctors' access to pharmaceutical representatives	Not restricted	Restricted
Duration of rotation on wards	6 months	4 months

DDD, defined daily dose; EARSS, European Antimicrobial Resistance Surveillance System; HPS, Health Protection Scotland; ICU, intensive-care unit; ID, infectious diseases; MRSA, methicillin-resistant *Staphylococcus aureus*.

and to fluoroquinolones in France in community-acquired infections, and *Staphylococcus aureus* resistance to methicillin in hospital-acquired infections in both countries. Rates of resistance in 2005 were obtained from national surveillance systems: the Observatoire National de l'Epidémiologie de la Résistance Bactérienne aux Antibiotiques (ONERBA, http://www.onerba.org) for France, and Health Protection Scotland for Scotland (http://www.hps.scot.nhs.uk). We also assessed knowledge of the local prevalence of antibiotic misuse; recent rates of misuse were obtained from local audits, published in Nice [3,13–16] and unpublished in Dundee. On the basis of a review of the literature [2,4–6,17], we selected nine essential steps of an antibiotic prescribing process, seven possible causes of antibiotic resistance and 14 possible interventions for inclusion in the questionnaire.

Survey administration

We distributed the questionnaire in November 2007 in Dundee, when the junior doctors had been working for 3 months. The doctors were asked to complete the survey at the beginning of a compulsory training session on sepsis management and prescribing. They had no prior warning of the survey. However, as only 75% or higher attendance at all sessions was required to complete their annual continuing professional requirements, the doctors could choose to be absent from these sessions. In Nice, the questionnaire was sent by E-mail and mail in January 2008, when the junior doctors had been working for 3 months and more, and could be returned by fax, E-mail or mail in the provided envelope. Questionnaires not returned within 3 weeks triggered E-mail and mail reminders. Questionnaires not returned within 6 weeks triggered telephone call reminders. A tracking number was used for each participant to ensure confidentiality.

Statistical methods

Percentages were calculated for the categorical data. Univariate analysis used the chi-square test for categorical data, or Fisher's exact test when needed. Results are presented for each hospital, and also combined when comparison of data from Dundee and Nice did not show any statistically significant difference. We analysed all data using SPSS software, version 15 (SPSS Inc., Chicago, IL, USA) and SAS software, version 8.2. All reported p-values were two-tailed, and a p-value <0.05 was considered to be significant.

Results

Of the 190 eligible junior doctors, 139 (73%) returned questionnaires, 63 of 90 (70%) in Dundee (all of the doctors who attended the training session) and 76 of 100 (76%) in Nice; 82 junior doctors were from medical specialties, and 39 were from surgical specialties (specialty was missing in 18 questionnaires). Thirty per cent of junior doctors did not attend their training session in Dundee, and 24% did not return the questionnaire in Nice. We can provide no reason for why they did not attend or return the questionnaires.

Antibiotic resistance

Importance of the problem of antibiotic resistance. Most respondents (95%) perceived antibiotic resistance as a national problem, but only 63% believed that it was a problem in their clinical practice (Table 2). The perception that resistance was a problem in clinical practice was not influenced by past training experience (77% vs. 72%, $\chi^2 = 0.35$, p 0.55, $n = 111$).

Perceptions of causes of antibiotic resistance. Three factors were perceived as being important causes of antibiotic resistance: prescription of too many antibiotics, prescription of too many broad-spectrum antibiotics, and prescription of subtherapeutic doses of an antibiotic (Fig. 1). The factors most frequently identified as unimportant or neutral were: paying too much attention to pharmaceutical representatives/advertising, excessive use of antibiotics in livestock, and poor hand hygiene. Dundee junior doctors were less likely to perceive drug advertising or subtherapeutic doses of an antibiotic as potential causes of resistance (Fig. 1).

Knowledge

Knowledge of the prevalence of antibiotic resistance. Any prevalence of *E. coli* resistance in community-acquired infections between 5% and 20% for trimethoprim in Scotland and <5% for fluoroquinolones in France was considered to be a correct answer. Dundee junior doctors gave correct prevalence rates in 56% of the questions, vs. 16% for Nice doctors (p <0.001) (Table 2). Knowledge of this prevalence rate was not influenced by past training experience (35% of correct answers among junior doctors who received some training vs. 32% of correct answers among those who were not trained; $\chi^2 = 0.12$, p 0.73, $n = 136$).

Any prevalence of *S. aureus* resistance to methicillin in hospital-acquired infections between 21% and 50% was considered to be a correct answer in both Scotland and France. Results in Nice and Dundee were not statistically different, with 26% of junior doctors giving the correct answer, and 48% of respondents underestimating the real prevalence (Table 2). Knowledge of this prevalence rate was not influenced by past training experience (26% of correct answers among junior doctors who received some training vs. 27% of

TABLE 2. Antibiotic resistance and prescribing: perceptions, knowledge and practice in Nice and Dundee

Question	Nice, *n* (%) *N* = 76	Dundee, *n* (%) *N* = 63	p-Value[a]	Combined answers, *n* (% (95% CI)) *N* = 139
Perception of the problem of antibiotic resistance[b]				
National problem	71/75 (95)	58/61 (95)	1	129/136 (95 (91–99))
Problem in the hospital	45/75 (60)	48/62 (77)	<0.03	–
Problem in clinical practice	51/75 (68)	33/59 (56)	0.15	84/134 (63 (54–71))
Knowledge of the correct rate of prevalence[b]				
Escherichia coli resistance	12/75 (16)	35/62 (56)	<0.001	–
Staphylococcus aureus resistance	22/75 (29)	14/62 (23)	0.37	36/137 (26 (19–34))
Antibiotic misuse	28/75 (37)	15/62 (24)	0.10	43/137 (31 (24–39))
Number of antibiotics prescribed in the last week				
≤2	39/74 (53)	27/62 (44)	0.42	66/136 (48 (40–57))
3–5	25/74 (34)	22/62 (35)	0.42	47/136 (35 (27–43))
>5	10/74 (14)	13/62 (21)	0.42	23/136 (17 (11–23))
Training in antibiotic prescribing in the last 12 months	45/76 (59)	51/61 (84)	0.002	–
Lectures	31/45 (69)	39/51 (76)	0.31	70/96 (73 (64–82))
Workshops	18/45 (40)	13/51 (25)	0.15	31/96 (32 (23–42))
Informal education in the clinical workplace	7/45 (16)	19/51 (37)	0.01	–
Web-based learning	4/45 (9)	26/51 (51)	<0.001	–
Self-directed learning	16/45 (36)	24/51 (47)	0.22	40/96 (42 (32–52))
Factors influencing antibiotic prescribing				
Previous experience	67/74 (91)	54/61 (89)	0.70	121/135 (90 (85–95))
Guidelines	67/74 (91)	59/61 (97)	0.18	126/135 (93 (89–98))
ID advice	50/74 (68)	38/61 (62)	0.52	88/135 (65 (57–73))
Senior colleague advice	44/74 (59)	60/61 (98)	<0.001	–
Microbiologist advice	17/74 (23)	57/61 (93)	<0.001	–
Pharmacist advice	2/74 (3)	48/61 (79)	<0.001	–

ID, infectious diseases.
[a]Data were compared between Nice and Dundee using the chi-square test or Fisher's exact test when needed.
[b]'Unsure' answers were grouped with 'no' answers for the analysis.

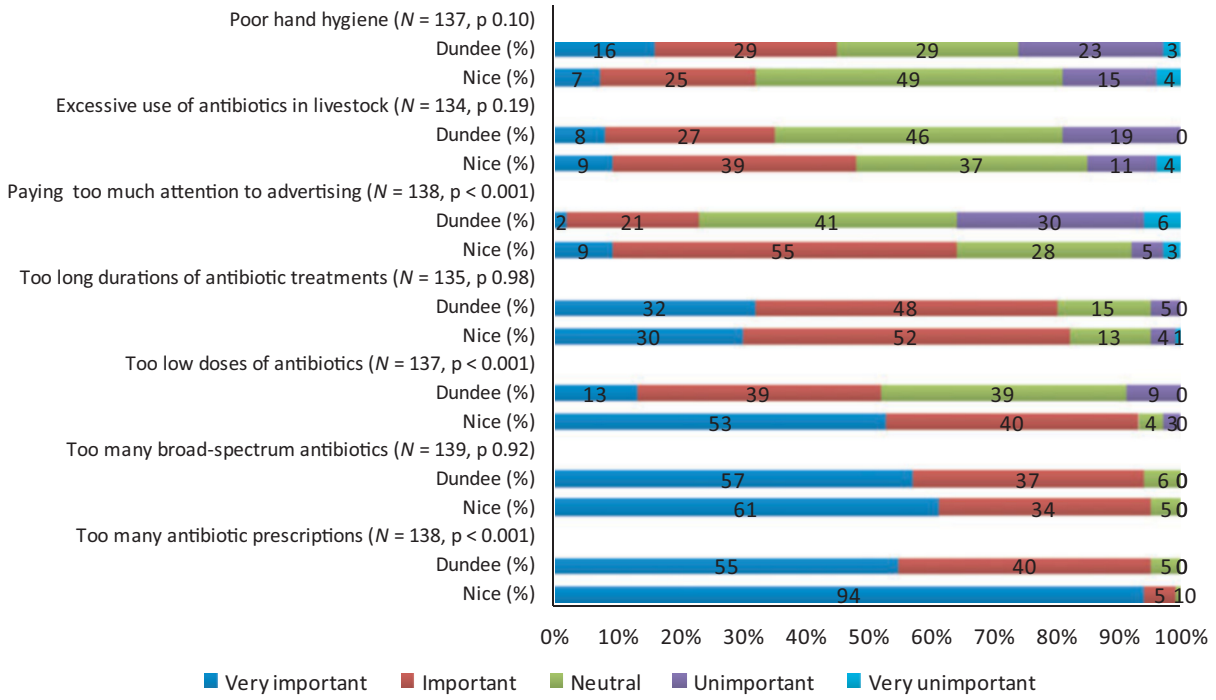

FIG. 1. Perceptions of causes of antibiotic resistance. Data from Nice and Dundee were compared using Fisher's exact test.

correct answers among those who were not trained; $\chi^2 = 0.004$, p 0.95, $n = 136$).

Knowledge of antibiotic misuse prevalence. Any prevalence of antibiotic misuse between 21% and 50% in both hospitals was considered to be a correct answer (see Participants and Methods). Results in Nice and Dundee were not statistically different, and the percentage of junior doctors giving the correct answer for the prevalence of antibiotic misuse was 31%, with 51% of respondents underestimating the real

prevalence (Table 2). Knowledge of this prevalence rate was not influenced by past training experience (31% of correct answers among junior doctors who received some training vs. 34% of correct answers among those who were not trained; χ^2 = 0.17, p 0.68, *n* = 136).

Antibiotic prescribing

All but two of 139 (1.4%) junior doctors had prescribed an antibiotic within the last 6 months. Forty-eight per cent of junior doctors had prescribed two or fewer antibiotics in the last week, 35% three to five antibiotics, and 17% more than five antibiotics, without any difference between the two hospitals (Table 2).

Ninety-six of 137 (70%) had received some training in antibiotic prescribing in the past 12 months, with doctors in Dundee having had more training than doctors in Nice (84% vs. 59%; χ^2 = 9.6, p 0.002, *n* = 137) (Table 2).

Attitudes during the antibiotic prescribing process. Junior doctors appear to feel relatively confident when prescribing an antibiotic, with Dundee junior doctors being more confident than Nice doctors for six of nine scenarios (Fig. 2).

Perceptions of the factors influencing the antibiotic prescribing process. Dundee junior doctors were more likely to seek advice from a senior colleague, a microbiologist or a pharmacist for their prescribing decisions than doctors in Nice (Table 2).

Perceptions of the helpfulness of potential interventions to improve antibiotic prescribing. The three measures rated as the most helpful interventions for improving prescribing were availability of guidelines, educational sessions, and availability of microbiological and infectious diseases advice (Fig. 3). Dundee junior doctors placed greater value on advice from a microbiologist, pharmacist and infection control team, although both groups appeared to value the availability of an antimicrobial management team. The influence of pharmaceutical representatives and restriction of all antibiotics were regarded as unhelpful (Fig. 3).

Discussion

Although 95% of our sample viewed antibiotic resistance as a national problem, only 63% believed that resistance

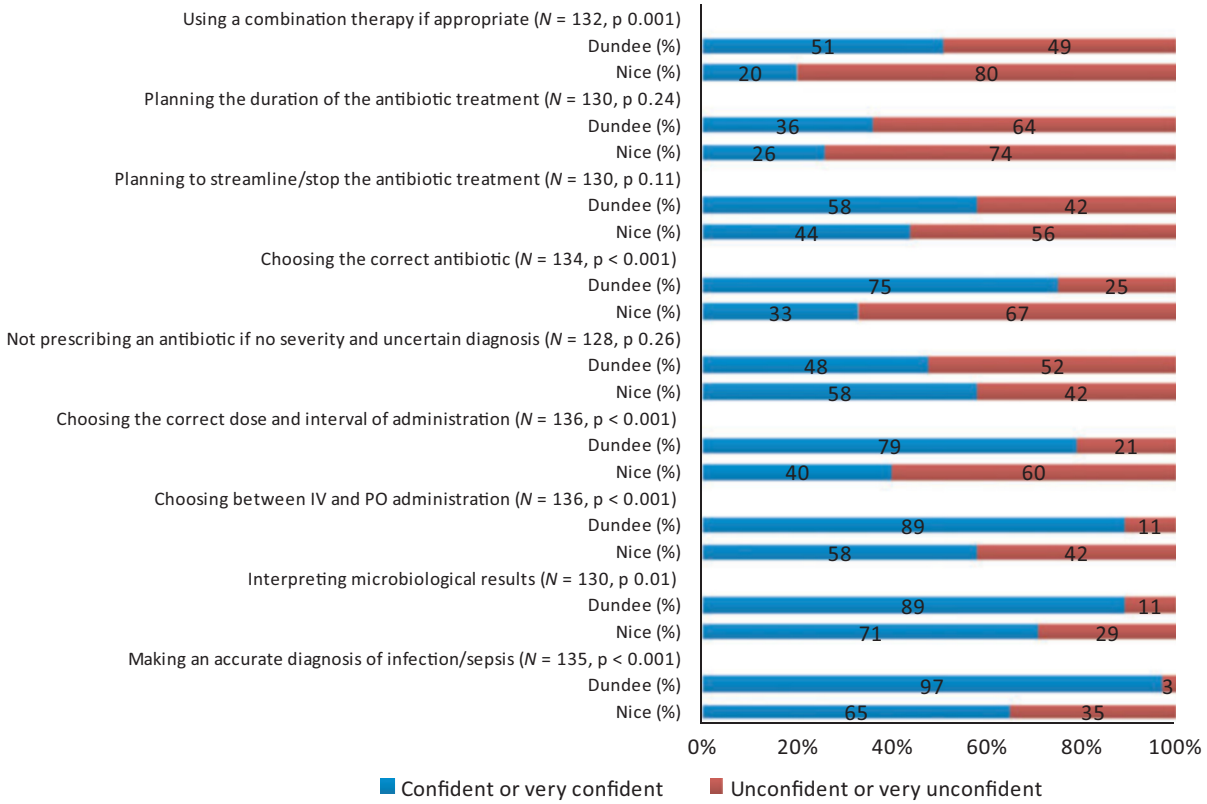

FIG. 2. Confidence level (percentage of doctors) for nine scenarios during an antibiotic prescribing process. Data were collapsed into two categories and compared between Nice and Dundee using Fisher's exact test. IV, intravenous; PO, oral.

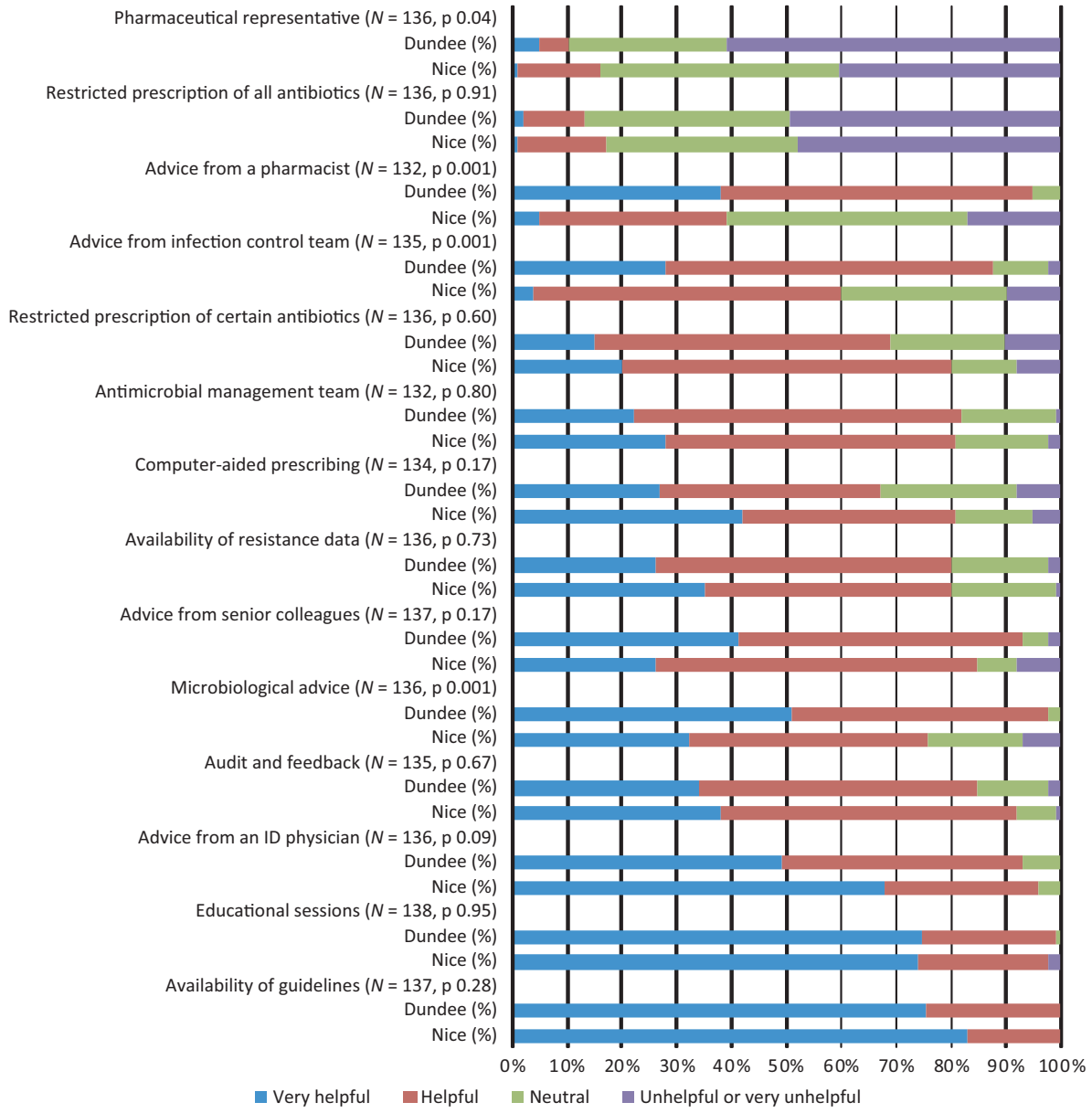

FIG. 3. Junior doctors' ratings of the helpfulness of potential interventions to improve antibiotic prescribing. Data from Nice and Dundee were compared using Fisher's exact test. ID, infectious diseases.

was a problem in their practice. These findings are consistent with those of a study of internists [9]. Other, more recent, studies have found a higher level of awareness of the problem of antibiotic resistance [10,11]. Training did not appear to be associated with a better awareness of antibiotic resistance in our study, although one survey of internal medicine junior and senior doctors found that previous personal experience with resistance was the best predictor of a better recognition of the problem of antibiotic resistance in practice [9].

Attitudes regarding the different components of the antibiotic prescribing process varied according to the scenario studied in our questionnaire. Junior doctors were most confident when making a diagnosis, and less confident in streamlining or stopping antibiotic therapy, planning the correct duration of treatment, or using a combination therapy appropriately. The high level of confidence reported in our study in making the correct diagnosis is not supported by evidence, as misdiagnosis has been shown to be the leading cause of unnecessary antibiotic prescriptions [3].

At both sites, junior doctors favoured more educative interventions to improve antibiotic prescribing rather than restrictive ones, as noted previously [9]. However, restriction of prescription of some antibiotics was perceived as helpful by the majority of respondents, possibly because this measure had been in place for a long time at both hospitals. Availability of advice from an infectious diseases specialist and a microbiologist as well as audit and feedback strategies were also highly valued by respondents. These findings are consistent with an Australian study surveying medical staff attitudes to an antibiotic approval and stewardship programme [18].

We observed many similarities between Nice and Dundee, thereby confirming the external validity of our results; most of the differences observed can be explained by the contextual differences detailed in Table 1. For example, Dundee doctors had a greater tendency than those in Nice to seek advice from a microbiologist or a pharmacist and to perceive them as helpful, probably because these professionals in Dundee are traditionally regarded as an easily accessible source of advice for junior doctors working on the wards.

To our knowledge, only three surveys published in English of antibiotic use and resistance have included junior doctors in the inpatient setting [9–11]. Only one of them [10] specifically surveyed junior doctors and studied antibiotic use. Therefore, our two-centre study of junior doctors at similar stages of training from all specialties in two European hospitals provides a unique comparison, and is strengthened by an adequate response rate of 73%, which is comparable with the rate of 67–87% in other published studies [9–11].

However, our study has significant limitations. First, as with most surveys, there is a possibility that respondents gave socially desirable answers. To minimize this potential bias, we ensured complete respondent confidentiality. We also believe that certain findings of the survey support its internal validity. For example, 30% of those surveyed stated that they had had no training in antibiotic prescribing in the past year, or some junior doctors rated the value of accessible advice from a pharmacist as being only moderately helpful in improving antibiotic prescribing, despite the perceived evidence of what would be regarded as a more desirable answer. Secondly, the differences in methodology in administering the questionnaire between Nice and Dundee might limit the comparability of the results, as the doctors in Dundee completed the questionnaire at a designated session and had no prior warning of the study. By contrast, doctors in Nice had the opportunity to verify their answers. However, we believe that the ability to verify answers would impact mostly on knowledge, and not on the assessment of perceptions. The fact that fewer than one-third of Nice junior doctors gave correct answers for prevalence rates, which are easily checkable, suggests that it is unlikely that they searched for answers. Finally, the small number of participating physicians could limit the validity of the results reported for physicians at large. However, 95% CIs for the combined answers in Table 2 were quite narrow, thereby strengthening the confidence in our results.

What have we learnt from these surveys that will help us to improve our interventions or their implementation and impact? Local guidelines need to give precise indications concerning intravenous–oral switch criteria, antibiotic combination choice criteria, and optimal durations of antibiotic treatments; this was not the case in one-fifth of 170 hospitals from 32 European countries [19]. Quality improvement interventions using an audit and feedback method are likely to be successful, as they will combine all factors valued by our respondents: value of experience, and advice from senior colleagues and various specialists (infectious diseases specialist in Nice and Dundee, with the addition of pharmacists and microbiologists in Dundee). We plan to focus on the reassessment of antibiotic prescriptions 2–4 days after the start of therapy, as it could improve issues such as the clarity of the diagnosis, intravenous–oral switch, and streamlining or cessation of therapy [4,20]. An outline of our practical implementation plan is described in Table S1.

Authorship/Contribution

C. Pulcini designed the study, collected the data, analysed the data, and wrote the article. F. Williams reviewed the study design, designed the questionnaire, and reviewed the article. N. Molinari checked the statistical analysis and reviewed the article. P. Davey and D. Nathwani reviewed the study design, contributed to the design of the questionnaire, and reviewed the article.

Acknowledgements

Some results of this study were presented previously at a scientific meeting: Dundee results were presented as a poster at the European Congress of Clinical Microbiology and Infectious Diseases (ECCMID) in 2008, and some of the results from Nice were presented as an oral presentation at the Réunion Interdisciplinaire de Chimiothérapie Anti-Infectieuses (RICAI) meeting in 2009. We would like to thank A. Naqvi for her help in sending the questionnaires, F. Gardella for her statistical assistance, and A. Sotto for his helpful advice.

Transparency Declaration

For the part of the study conducted in Scotland, C. Pulcini was supported by grants from the NHS Education Scotland, University of Medicine in Nice (France) and REDPIT association (Recherche et Développement en Pathologie Infectieuse et Tropicale, Nice, France). There was no involvement of study sponsors in the study design, in the collection, analysis and interpretation of data, in the writing of the manuscript, or in the decision to submit the manuscript for publication. D. Nathwani has received honoraria for serving on advisory boards or speaking at symposia supported by Wyeth, Pfizer, Jonhson & Johnson and Novartis, all of which produce anti-infectives. He has no conflicts of interest to declare with respect to the contents of this manuscript. P. Davey has received research funding from Pfizer and Jansen Cilag, which produces anti-infectives. He has no conflicts of interest to declare with respect to the contents of this manuscript. All other authors have no conflicts to declare.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Practical plan for specific interventions to be implemented in each hospital.

Questionnaires. In both English and French.

Please note: Wiley-Blackwell are not responsible for the content or functionality of any supporting materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

References

1. Cosgrove SE. The relationship between antimicrobial resistance and patient outcomes: mortality, length of hospital stay, and health care costs. *Clin Infect Dis* 2006; 42 (suppl 2): S82–S89.
2. Dellit TH, Owens RC, McGowan JE Jr *et al.* Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 2007; 44: 159–177.
3. Pulcini C, Cua E, Lieutier F, Landraud L, Dellamonica P, Roger PM. Antibiotic misuse: a prospective clinical audit in a French university hospital. *Eur J Clin Microbiol Infect Dis* 2007; 26: 277–280.
4. Haute Autorité de Santé. Recommandations professionnelles—stratégie d'antibiothérapie et prévention des résistances bactériennes en établissement de santé. April 2008.
5. Société de Pathologie Infectieuse de Langue Française. Comment améliorer la qualité de l'antibiothérapie dans les établissements de soins? *Méd Mal Infect* 2002; 32: 320–328.
6. Nathwani D. Antimicrobial prescribing policy and practice in Scotland: recommendations for good antimicrobial practice in acute hospitals. *J Antimicrob Chemother* 2006; 57: 1189–1196.
7. Davey P, Brown E, Fenelon L *et al.* Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev* 2005; CD003543.
8. Cabana MD, Rand CS, Powe NR *et al.* Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999; 282: 1458–1465.
9. Wester CW, Durairaj L, Evans AT, Schwartz DN, Husain S, Martinez E. Antibiotic resistance: a survey of physician perceptions. *Arch Intern Med* 2002; 162: 2210–2216.
10. Srinivasan A, Song X, Richards A, Sinkowitz-Cochran R, Cardo D, Rand C. A survey of knowledge, attitudes, and beliefs of house staff physicians from various specialties concerning antimicrobial use and resistance. *Arch Intern Med* 2004; 164: 1451–1456.
11. Guerra CM, Pereira CA, Neves Neto AR, Cardo DM, Correa L. Physicians' perceptions, beliefs, attitudes, and knowledge concerning antimicrobial resistance in a Brazilian teaching hospital. *Infect Control Hosp Epidemiol* 2007; 28: 1411–1414.
12. Giblin TB, Sinkowitz-Cochran RL, Harris PL *et al.* Clinicians' perceptions of the problem of antimicrobial resistance in health care facilities. *Arch Intern Med* 2004; 164: 1662–1668.
13. Pulcini C, Mondain V, Lieutier F, Mousnier A, Roger PM, Dellamonica P. Fluoroquinolone prescriptions in a teaching hospital: a prospective audit. *Scand J Infect Dis* 2007; 39: 1013–1017.
14. Pulcini C, Pradier C, Samat-Long C *et al.* Factors associated with adherence to infectious diseases advice in two intensive care units. *J Antimicrob Chemother* 2006; 57: 546–550.
15. Roger PM, Farhad R, Pulcini C *et al.* Elderly patients presenting with fever and respiratory problems in an intensive care unit. Diagnostic, therapeutic and prognostic impact of a systematic infectious disease consultation. *Presse Med* 2003; 32: 1699–1704.
16. Roger PM, Martin C, Taurel M *et al.* Motives for the prescription of antibiotics in the emergency department of the University Hospital Center in Nice. A prospective study. *Presse Med* 2002; 31: 58–63.
17. Stephenson J. CDC campaign targets antimicrobial resistance in hospitals. *JAMA* 2002; 287: 2351–2352.
18. Bannan A, Buono E, McLaws ML, Gottlieb T. A survey of medical staff attitudes to an antibiotic approval and stewardship programme. *Intern Med J* 2009; 39: 662–668.
19. Bruce J, MacKenzie FM, Cookson B *et al.* Antibiotic stewardship and consumption: findings from a pan-European hospital study. *J Antimicrob Chemother* 2009; 64: 853–860.
20. Pulcini C, Defres S, Aggarwal I, Nathwani D, Davey P. Design of a 'day 3 bundle' to improve the reassessment of inpatient empirical antibiotic prescriptions. *J Antimicrob Chemother* 2008; 61: 1384–1388.